The bull ray, *Pteromylaeus bovinus* (Myliobatidae), in the northern Adriatic Sea

by

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ABSTRACT. - The authors report captures of the bull ray *Pteromylaeus bovinus* in northern Adriatic where the species was previously considered as rare. Among the captured specimens were found pregnant females bearing near term embryos, ranging between 370 mm and 450 mm disc width and weighing between 740 and 1080 g. Some of observed bull rays were the largest specimens recorded to date; they ranged between 1540 and 2220 mm disc width and between 68 and 116 kg total weight. Comments are provided on the occurrence of the species in the area and on these uncommon sizes.

RÉSUMÉ. - L'aigle-vachette *Pteromylaeus bovinus* (Myliobatidae) en Adriatique septentrionale.

Les auteurs relatent des captures d'aigles-vachettes *Pteromylaeus bovinus* en Adriatique septentrionale où l'espèce était préalablement considérée comme rare. Parmi les spécimens capturés, on a trouvé des femelles gestantes portant des embryons à terme, mesurant entre 370 et 450 mm de largeur discale et pesant entre 740 et 1080 g. Quelques-unes des aigles-vachettes observées constituent les plus grands spécimens enregistrés à ce jour; ils mesuraient entre 1540 et 2220 mm de largeur discale et pesaient entre 68 et 116 kg. Des commentaires sont présentés sur la présence de l'espèce dans la région et sur ces tailles peu communes.

Key words. - Myliobatidae - *Pteromylaeus bovinus* - MED - Northern Adriatic - Maximal size.

The bull ray, *Pteromylaeus bovinus* (Geoffroy Saint-Hilaire, 1817) is a benthopelagic species, sometimes captured in small groups, in coastal and warm temperate waters, occasionally offshore, at depths between 10 and 150 m (Capapé and Quignard, 1975). It mainly feeds on bivalves, gastropods and bottom-living crustaceans, occasionally on cephalopods and teleosts (Capapé, 1977a; Schneider, 1990).

P. bovinus is reported in the Eastern Atlantic from Portugal and Morocco to Angola including Madeira and the Canary Islands, from Saldanha Bay to Natal (South Africa) and also southern Mozambique (Compagno *et al.*, 1989).

In the Mediterranean, *P. bovinus* is more frequently captured in the eastern basin than in the western basin, generally in southern areas (Capapé, 1989). For instance, the bull ray was only reported off the Mediterranean coast of France by Moreau (1881), further papers did not report it (Euzet, 1960; Quignard *et al.*, 1962; Capapé, 1977b; Quignard and Raibaut, 1993; Capapé *et al.*, in press) and observations carried out to date in the area did not allow to record the species.

Southward, *P. bovinus* was reported throughout the North African shore: Morocco (Collignon and Aloncle, 1972), Algeria (Dieuzeide *et al.*, 1953) and Tunisia (Capapé and Quignard, 1975). Off Tunisia, Quignard and Capapé (1971) previously noted that bull rays were more abundantly caught in southern areas. Recent observations carried out in the Tunisian waters showed that *P. bovinus* migrated towards more northern areas and entered brackish water areas such as the Lagoon of Bizerte (Neifar *et al.*, 1999) and Tunis Southern Lagoon (Mejri *et al.*, 2004).

The bull ray was previously reported as a rare elasmobranch species in the Adriatic Sea (Šoljan, 1963, 1975; Jardas, 1985, 1996), however recent investigations made in the area allowed to collect several specimens, which constitute the focus of the present paper.

MATERIAL AND METHODS

Thirty-two *Pteromylaeus bovinus* were captured in the period August-October 2005 (Tab. I) by trawl (commercial vessels) in the southern part of the Gulf of Trieste and off the western coast of Istria (northern Adriatic) (Fig. 1). Trawling occurred in the shallow coastal areas at a muddy and muddy-detritic bottom at a depth from 20 to 30 m.

Eleven of the 32 specimens (Fig. 2) were measured to the

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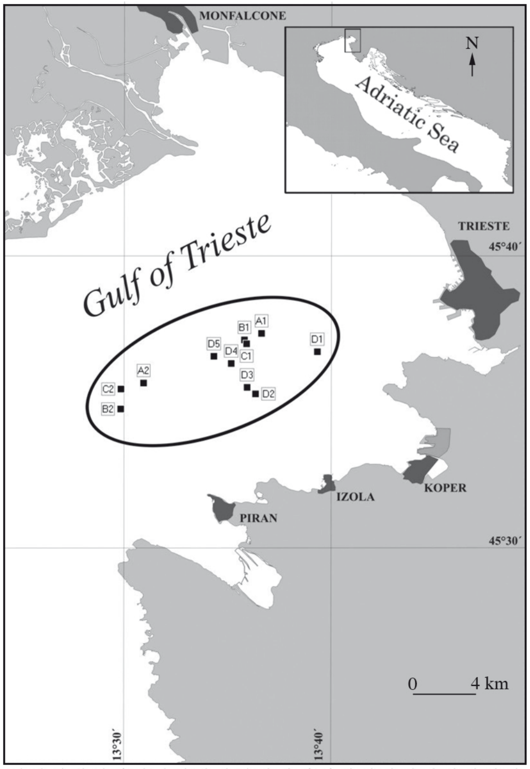

Figure 1. - Map showing the locality of catch. *[Carte montrant le site de capture.]*

nearest millimetre and weighed to the nearest gram; the data are included in table I. Measurements partially followed Capapé and Quignard (1975) and Mejri *et al*. (2004); they are included in table I. Unfortunately, specimens were not preserved since all of them were transported to the fish market.

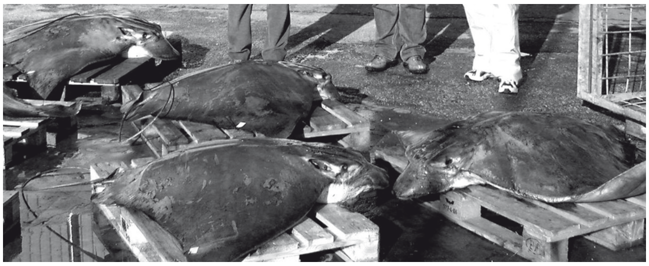

Figure 2. - Some specimens of the bull ray caught in the northern Adriatic. *[Quelques* Pteromylaeus bovinus *capturés en Adriatique septentrionale.]*

Three categories of specimens were distinguished: embryos, juveniles and adults. Embryos were removed from pregnant females when caught. Juveniles and adults were considered from the condition of genital duct, gonads, the condition of claspers and the development of pre-orbitary tubercles in males, and the presence of embryos in female uteri.

Linear regression (total mass TM *versus* disc width DW) was performed following log transformation of data. Correlations were assessed by least-squares regression.

RESULTS

Among the 32 specimens, 28 were free-swimming specimens and 4 were embryos. Free-swimming specimens comprised 12 males and 15 females; moreover, a single specimen was not sexed. All the observed embryos were males.

Table I. - Measurements (in mm) for the 11 specimens of bull ray *Pteromylaeus bovinus* caught in the Northern Adriatic. *[Mensurations (mm) relevées chez 11* P. bovinus *capturés en Adriatique septentrionale.]*

Specimens	1		2		3		4		5		6		7		8		9		10		11	
Total mass (kg)	12.7		21		68		57		68		74		87		84		110		116		88	
Measurements	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW	mm	%DW
Total length	1685	171.0	1940	171.0	1690	107.7	2500	162.3	2660	167.3	1960	120.4	1890	111.2	2630	153.8	2240	118.8	2940	153.9	2200	100.0
Disc length	600	61.0	715	63.0	1082	69.0	1080	70.1	1100	69.2	1080	66.3	1145	67.4	1125	65.8	1180	62.6	1320	69.1	1155	52.0
Disc width	985	100.0	1135	100.0	1569	100.0	1540	100.0	1590	100.0	1630	100.0	1700	100.0	1710	100.0	1885	100.0	1910	100.0	2220	100.0
Trunk length	310	31.5	380	33.5	618	33.5	555	36.0	570	35.8	600	36.8	620	36.5	630	36.8	675	35.8	670	35.1	620	28.0
Head length	259	26.3	467	41.1	302	31.6	486	31.6	500	31.4	470	28.8	520	30.6	500	29.2	525	27.9	580	30.4	510	23.0
Head width	118	12.0	142	12.5	193	13.3	205	13.3	205	12.9	210	12.9	220	12.9	215	12.6	245	13.0	250	13.1	225	10.1
Pre-orbital length	95	9.6	117	10.3	185	13.6	210	13.6	180	11.3	210	12.9	225	13.2	200	11.7	225	11.9	250	13.1	210	9.5
Neck length	132	13.4	163	14.4	255	16.2	250	16.2	280	17.6	220	13.5	290	17.1	300	17.5	280	14.9	325	17.0	280	12.6
Pre-oral length	127	12.9	136	12.0	205	13.6	210	13.6	210	13.2	210	12,9	220	12.9	225	13.2	241	12.8	245	12.8	210	9.5
Internasal width	38	3.9	50	4.4	76	6.2	95	6.2	92	5.8	105	6.4	100	5.9	140	8.9	120	6.4	125	6.5	110	5.0
Eye length	17	1.7	16	1.4	23	1.4	21	1.4	24	1.5	19	1.2	24	1.4	28	1.6	26	1.4	21	1.1	22	0.9
Mouth width	57	5.8	73	6.4	121	7.8	120	7.8	121	7.6	150	9.2	135	7.9	110	6.4	165	8.8	180	9.4	155	7.0
Sting length	39	4.0	47	4.1	-	-	-	-	33	2.1	46	2.8	-	-	22	1.3	22	1.2	-	-	62	2.8
Tail length	1065	108.1	1285	113.2	640	100.6	1550	100.6	1580	99.4	880	54.0	842	49.6	1490	87.1	1100	58.4	1680	88.0	1550	69.8
Postcloacal length	571	58.0	681	60.0	1060	67.2	1035	67.2	1065	67.0	1050	64.4	1110	65.3	1130	66.1	1200	63.7	1250	65.4	1120	50.5
Spiracle length	55	5.6	65	5.7	90	68.0	68	4.4	82	5.2	100	6.1	97	5.7	102	6.0	116	6.2	121	6.3	86	3.9

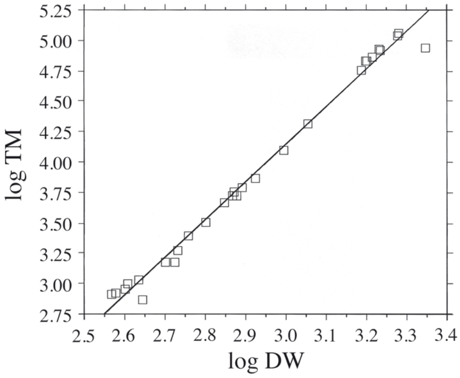

Figure 3. - The relationship total mass TM *versus* disc width (DW) for *Pteromylaeus bovinus* (log TM = 3.095 log DW - 5.138; n = 32; r = 0.99). *[Relation entre la masse totale (TM) et la largeur du disque (DW) chez* P. bovinus.*]*

Embryos were 370-450 mm DW. Of the 28 free-swimming bull rays, six specimens (two males and 4 females) ranged 380-440 mm DW and weighed 740-1080 g. Their DW was similar in those embryos, so they could be considered as neonates.

Of the 12 males, 7 were juveniles and 5 adults. The juvenile males had short and flexible claspers and both testes and genital duct were thread-like and undeveloped, they ranged 349-535 mm DW and weighed from 0.9 to 1.88 kg. In the five adult males, the claspers were rigid, elongated and calcified. The testes were developed, with spermatocysts externally visible. The genital duct was conspicuously developed and the ductus deferens (*sensu* Hamlett *et al*., 1999) clearly twisted. Moreover, the adult males exhibited pre-orbitary tubercles morphologically similar to those described in *P. bovinus* from the Tunisian coast (Capapé and Quignard, 1975) and the coast of Senegal (Seck *et al*., 2002). Adult males ranged from 735 to 1135 mm DW and weighed from 5.30 to 21 kg. Measurements of the two largest males are given in table 1 (specimens 1, 2).

Of the 15 females, 5 were juveniles and 10 adults. The juveniles had whitish ovaries, thread-like genital duct with indistinct oviduct glands. The juvenile females ranged 528-839 mm DW and weighed 1500-7400 g. Adult females exhibited a completely developed genital duct, 9 females were pregnant. They ranged 1540-2220 mm TL and weighed from 68 to 116 kg. Measurements and masses of the 9 adult females are given in table I (specimens 3 to 11).

The relationship total mass TM *versus* disc width (DW) for the total sample is:

log TM = 3.095 log DW - 5.138; n = 32; r = 0.99 (Fig. 3).

DISCUSSION

Pteromylaeus bovinus was formerly considered as a rare species in the northern Adriatic Sea (Ninni, 1912; Šoljan, 1963; Tortonese, 1956). In a one year long study of cephalopod and fish species sampled monthly by the mean of a bottom trawl in the southern part of the Gulf of Trieste, Marčeta (1996) recorded only few specimens of *Myliobatis aquila*. No specimens of *P. bovinus* are reported in the checklist of the fauna and flora of the northern Adriatic (Matjašić *et al*., 1976). According to the ichthyological surveys and checklists of Jardas *et al*. (1998), Kovačić (1998) and Zavodnik and Kovačić (2000) the bull ray is absent in the Rijeka Bay, too. The rarity of *Pteromylaeus bovinus* captures in the Northern Adriatic could be explained by at least two possibilities. The first one is that specimens of bull ray inhabit the area regularly, but since they have not an important economical value, they are generally discarded at sea such as other elasmobranch species (Mavrič *et al*., 2004). The second possibility, which could not be excluded, is that these captures could also constitute a new instance of the northward spreading of thermophilous southern species in the area, such as previously recorded for various teleost species (Dulčić *et al*., 1999; Lipej and Dulčić, 2004). The phenomenon is related to fact that the whole Adriatic waters are facing the increase of temperature in the surface layer in the last hundred years (see for example Dulčić *et al*., 2004, 2007).

Our sample comprised neonates, adult males and females, and among the latter several pregnant specimens. Pregnant *P. bovinus* approached inshore waters in order to find favourable environmental conditions to expel the near term embryos. However, at present, our data are still insufficient to state whether the Northern Adriatic shore is a specialized area for elasmobranch species (*sensu* Castro, 1993). On the other hand this area is rather shallow and muddy, somehow resembling the Gulf of Gabes (Tunisia), a reproducing ground for the bull ray (Capapé and Quignard, 1975).

The largest *P. bovinus* included in table II show that females are larger than males, similar patterns were observed by Capapé and Quignard (1975) and Seck *et al*. (2002) for

Area	Size at birth (DW, mm)	Maximal size (DW, mm)		Authors
		Males	Females	
Coast of Tunisia	250-290	1040	1460	Capapé and Quignard, 1975
Mediterranean	450			McEachran and Capapé, 1986
Coast of Senegal	250-270	1150	1480	Seck *et al*., 2002
Tunis southern lagoon	310			Mejri *et al*., 2004
Northern Adriatic	370-450	1135	1540-2220	This study

Table II. - Size at birth and maximal size (DW in mm) of *Pteromylaeus bovinus* given by different authors. *[Taille à la naissance et taille maximale (largeur discale = DW en mm) de* P. bovinus *données par différents auteurs.]*

specimens from the coast of Tunisia and the coast of Senegal, respectively. This confirms sexual dimorphism for *P. bovinus* such as for other elasmobranch species (Mellinger, 1989; Capapé *et al.*, 2004).

Measurements carried out in near term embryos and neonates suggest that size at birth occurred between 370 and 450 mm DW, at a larger DW than those observed in specimens from both Tunisian and Senegalese waters (Tab. II). Seck *et al.* (2002) noted that the smallest free-swimming *P. bovinus* was 335 mm DW and Mejri *et al.* (2004) described a neonate 310 mm DW caught in the Tunis Southern Lagoon. McEachran and Capapé (1986) noted 450 mm DW for size at birth in Mediterranean specimens (Tab. II). However, large differences in size at birth were observed in elasmobranch viviparous species related to the area (Capapé *et al.*, 2006).

Larger size at birth could explain why bull rays (especially females, specimens 3 to 9 in table I) from the Northern Adriatic reached a larger maximal size than those of other areas (Tab. II); they are also the largest specimens of *P. bovinus* recorded to date. Moreover, the maximal mass recorded in the study was 116 kg, while maximum reported until now, for the whole distribution area, was 86 kg (Compagno, 1986).

Bauer (1961) noted that the increased body size might be linked to discrepancies in external morphological characters caused by parasitic infestation. The bull rays from the Northern Adriatic did not suffer any parasitic infections and had morphometric measurements within interval described for this species (Capapé and Quignard, 1975; Mejri *et al.*, 2004). By contrast, *P. bovinus* from the Tunisian waters and the coast of Senegal were infested by both copepod (Raibaut and Maamouri, 1975, Essafi and Raibaut, 1977, Raibaut, pers. comm., 2006) and monogen species (Neifar *et al.*, 1999, Euzet, pers. comm., 2006). Moreover, the uncommon growth observed could be also explained as the result of hereditary factors or some sort of glandular disturbance, which affect the physiology of specimens.

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